



Status of Scenario Generation Task

Scenario Metrics

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Scenario Metrics Overview

- Provide review of scenario metrics being developed
- Metrics defined in *Description of Accuracy Scenarios for the Acceptance Testing of URET CCLD*,
Review Draft 9/14/99
- Results based on preliminary scenarios
 - **proof of concept only**
- Two preliminary scenarios for calculating results
 - Five hour modestly time shifted ZME scenario from 5/26/99
 - Ten hour ZME scenario from 5/26/99 (not time shifted)





List of Areas used to Generate Scenario Metrics

- **Center Airspace** ✓
- **Encounters** ✓
- **Air Traffic** ✓
- **Aircraft** ✓
- **Interfacility Traffic Flow**
- **Flight Plan Adherence**
- **Weather Forecasts**





Center Airspace

- **Defining Characteristics**
 - Airports
 - Sectors
 - Airways
 - Preferential Routes
 - Special Use Airspace
 - Terminal Areas (APDIA)
 - Fix Posting Areas
- **Metrics**
 - Total Count





Encounter Distributions

- **Aircraft to Aircraft Encounters**
- **Aircraft to Airspace Encounters**





Encounter Distributions

- **Aircraft to Aircraft Encounters**
 - Tracks of aircraft pairs within 30 nm and violate standard vertical thresholds
- **Metrics**
 - Count of Encounters partitioned by Minimum Horizontal Separation Intervals
 - Count by Altitude Interval
 - Count by Encounter Angle and Vertical Phase of Flight





Counts of Aircraft to Aircraft Encounters

Minimum Horizontal Separation (nm)	Number of Encounters
$0 \leq d < 5$	200
$5 \leq d < 10$	198
$10 \leq d < 15$	280
$15 \leq d < 23$	527
$23 \leq d < 30$	486
Total	1691

Statistics for 5 hour sample
ZME without FP adherence



Table A.1-1



Count by Phase of Flight and Encounter Angle

Vertical Phase of Flight	Encounter Angles (degrees)			
	[0,45)	[45,90)	[90,135)	[135,180]
Cruise-Cruise	81	110	69	37
Descend-Descend	60	24	11	13
Climb-Climb	40	11	5	11
Unknown	15	0	2	1
Cruise-Climb	139	91	88	146
Cruise-Descend	182	122	103	156
Climb-Descend	52	20	29	73

Statistics for 5 hour sample
ZME without FP adherence

Table A.1-2





Encounter Distributions

- **Aircraft to Airspace Encounters**
 - Track of aircraft within 30 nm of Special Use Airspace
- **Metrics**
 - Count of Encounters partitioned by Minimum Horizontal Separation Intervals
 - Count by Altitude Intervals
 - Count by Encounter Angle and Vertical Phase of Flight





Counts of Aircraft to Airspace Encounters

Minimum Horizontal Separation (nm)	Number of Encounters
$0 \leq d < 7$	1725
$7 \leq d < 9$	134
$9 \leq d < 11$	151
$11 \leq d < 16$	444
$16 \leq d < 30$	1278
Total	3632

Statistics for 5 hour sample
ZME without FP adherence



Table A.2-1



Air Traffic Distributions

- **Air Traffic Density**
- **Active Flights**
- **Flight Type & Sector Penetration**
- **Aircraft Ground Speed**
- **Flight Life**
- **Center to APD Ratio**
- **Center Boundary Activity**
- **Aircraft Maneuvers**





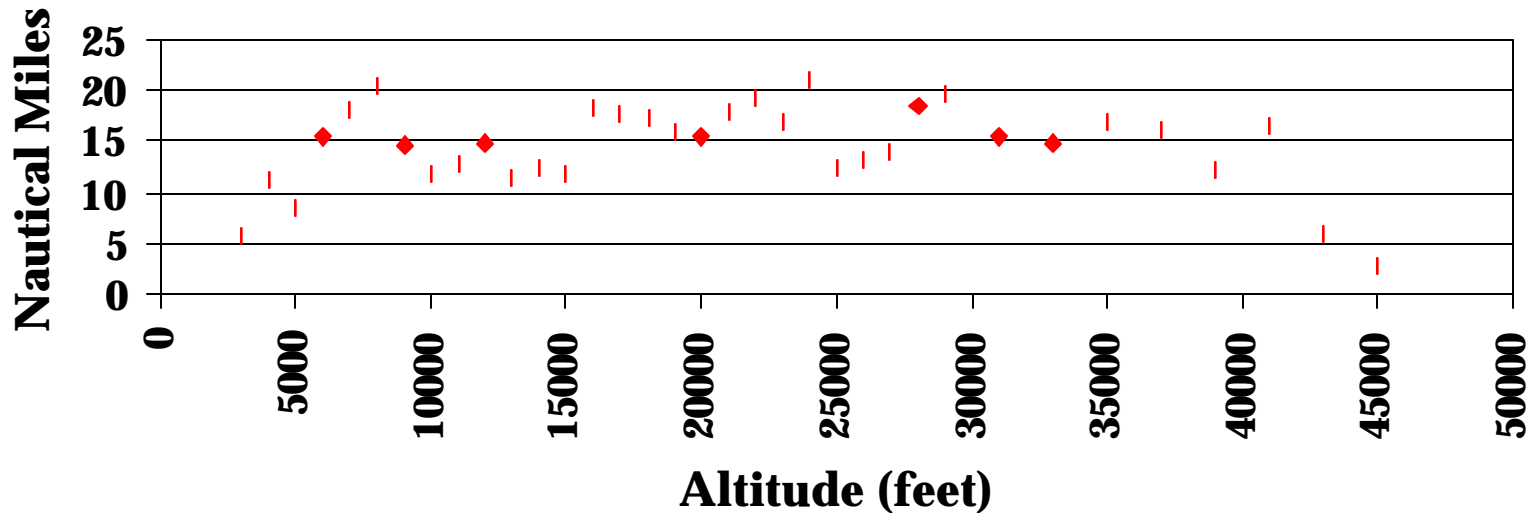
Air Traffic Distributions

- **Air Traffic Density**
 - Minimum horizontal separation partitioned by altitude and time
 - 1000/2000 foot vertical partitions
 - One hour segments
- **Metrics**
 - Mean
 - Variance





Average Hourly Minimum Horizontal Separation by Altitude



Statistics for 5 hour sample
ZME without FP adherence





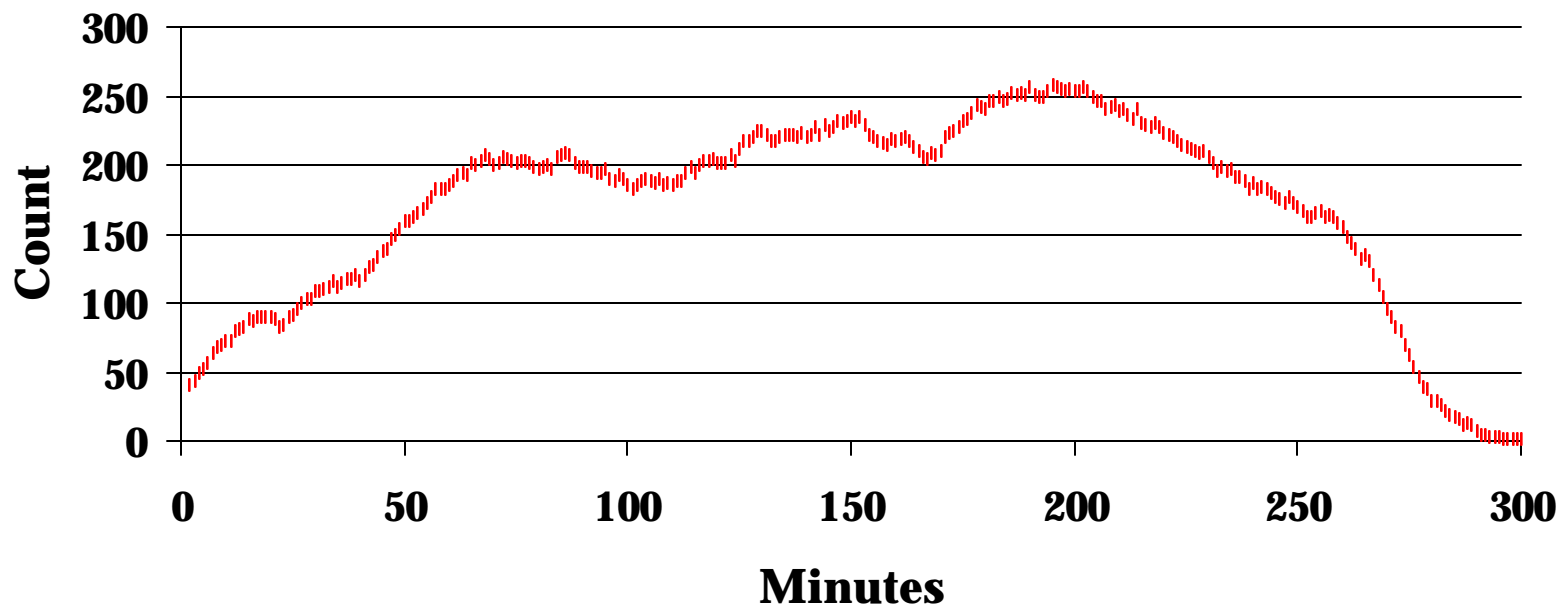
Air Traffic Distributions

- **Active Flights**
 - Measure of the number of flights operating in center by time
- **Metrics**
 - Total count
 - Count by minute





Count of Flights by Minute



Statistics for 5 hour sample
ZME without FP adherence



Figure B.2-1



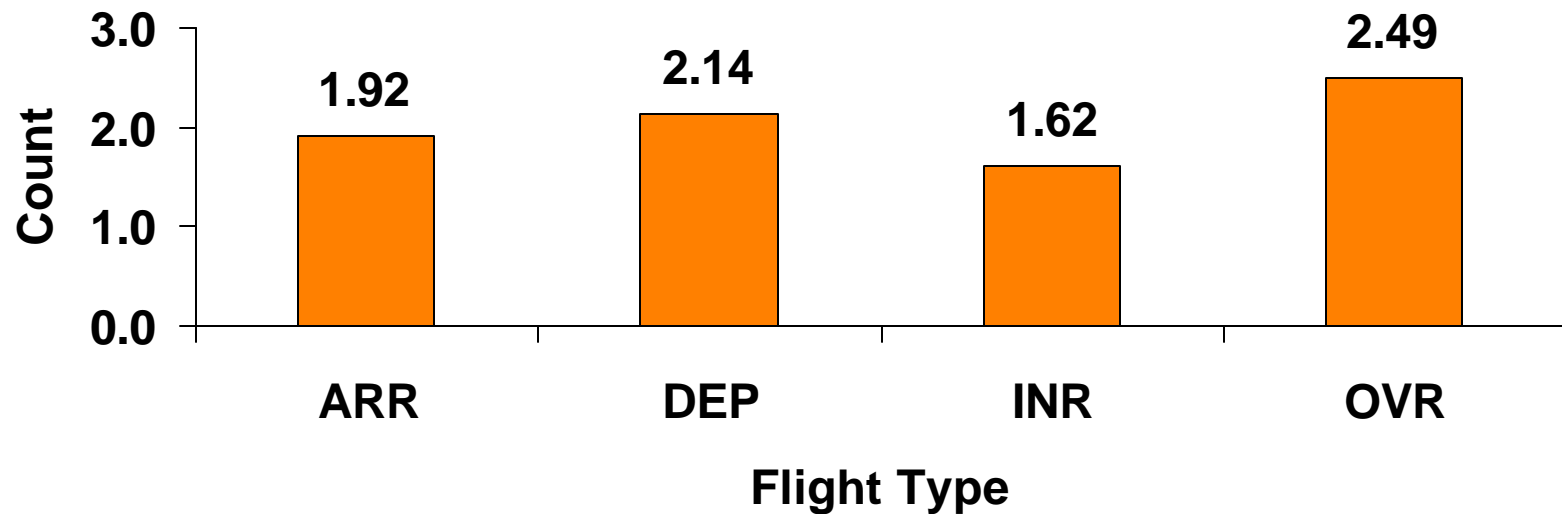
Air Traffic Distributions

- **Flight Type and Sector Penetration**
 - Distribution of flight type by number of sectors penetrated and time duration
 - ARR, DEP, OVR, INR
- **Metrics**
 - Average sectors penetrated by flight type
 - Average time in sector
 - Average time in center
 - Percentage in center by flight type





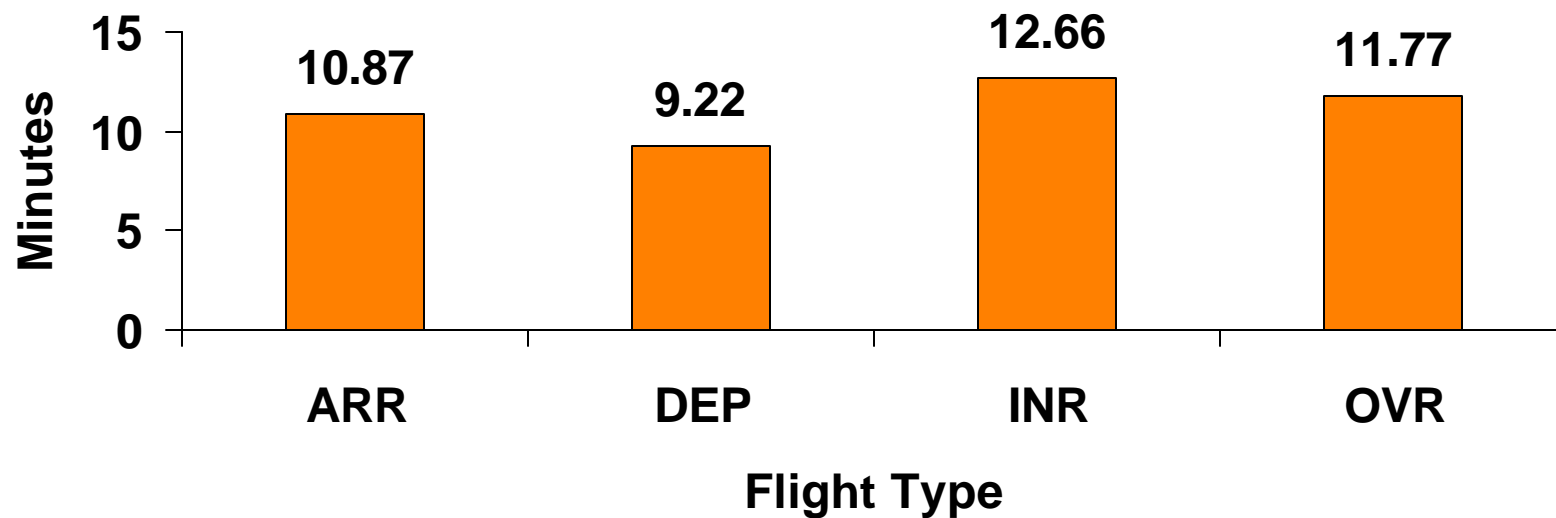
Average Number of Sectors Penetrated by Flight Type



Statistics for 5 hour sample
ZME without FP adherence



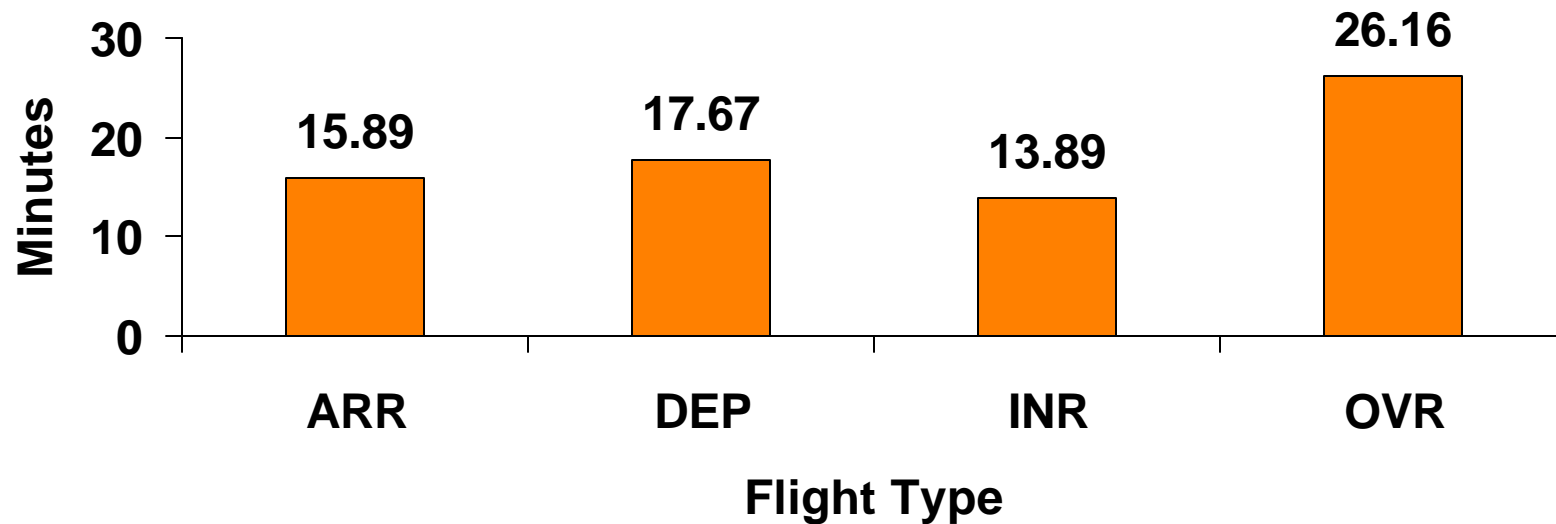
Average Time in Sector by Flight Type



Statistics for 5 hour sample
ZME without FP adherence



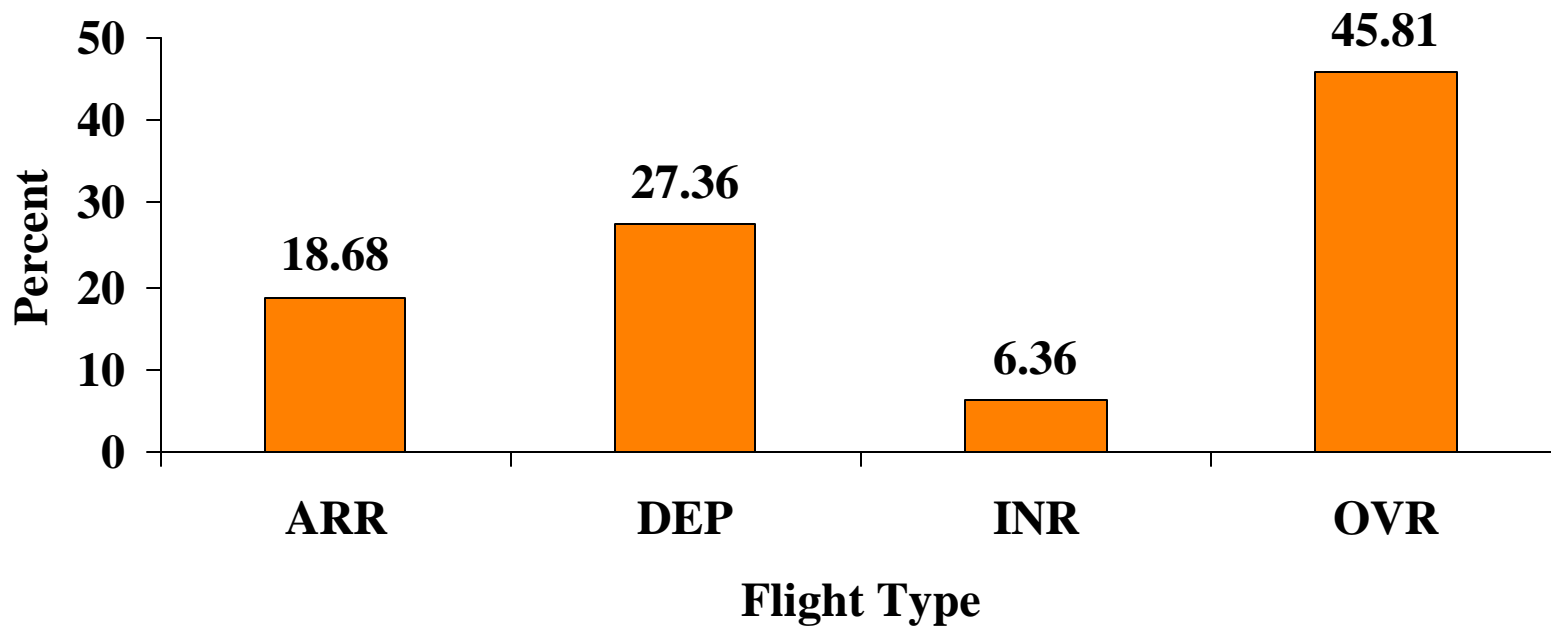
Average Time in Center by Flight Type



Statistics for 5 hour sample
ZME without FP adherence



Percentage of Flights by Flight Type



Statistics for 5 hour sample
ZME without FP adherence



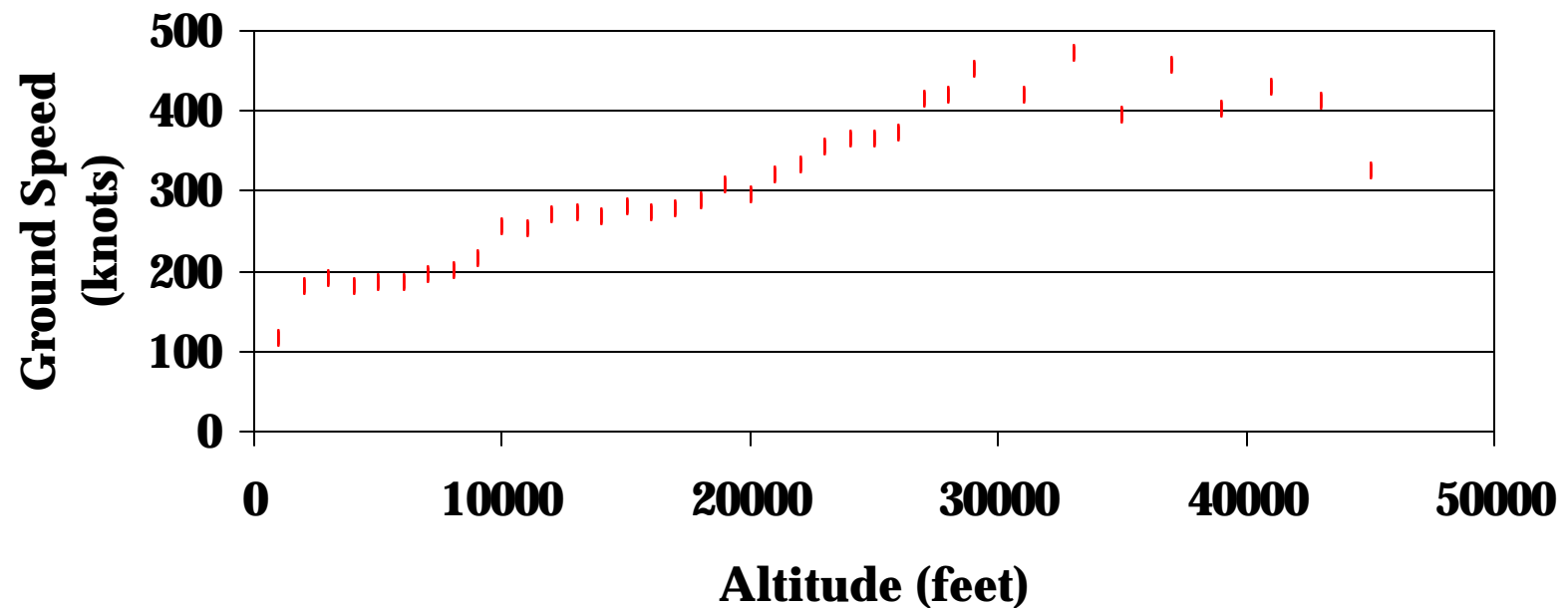
Air Traffic Distributions

- **Ground Speed**
 - Flight ground speed partitioned by standard altitude intervals
- **Metrics**
 - Mean
 - Variance





Average Ground Speed by Altitude



Statistics for 5 hour sample
ZME without FP adherence



Figure B.4-1



Air Traffic Distributions

- **Flight Life**

- Measure of the average time duration of a track in center

- **Metrics**

- Mean
- Std Deviation

- **Results**

- Mean 35.25 minutes
- Std Dev 19.62 minutes

Statistics for 10 hour sample
ZME without FP adherence





Air Traffic Distributions

- **Center to APD Ratio**
 - Ratio of track reports for flights within center to total HCS track reports (center + APD zone)
- **Metrics**
 - Ratio or Percent
- **Results**
 - TBD





Air Traffic Distributions

- **Center Boundary Activity**
 - Rate of flight entering and leaving center airspace
 - Measure of flight activity crossing center boundary
- **Metrics**
 - Count per unit time
- **Results**
 - TBD





Air Traffic Distributions

- **Interim Altitude Messages**
 - Interim Altitude Messages per Flight
- **Metrics**
 - Count per unit time
- **Results**
 - TBD





Air Traffic Distributions

- **Air Traffic Maneuvers**
 - Turns by altitude interval
 - Ascents and descents by altitude interval
- **Metrics**
 - Total Count
- **Results**
 - TBD





Aircraft Distributions

- **Aircraft Type**
- **Aircraft Model**
- **Navigation Equipage**
- **Carrier**





Aircraft Distributions

- **Aircraft Type Distribution**

- Distribution of all aircraft operating in center by type classification
- Piston, Turboprop, Jet, Helicopter

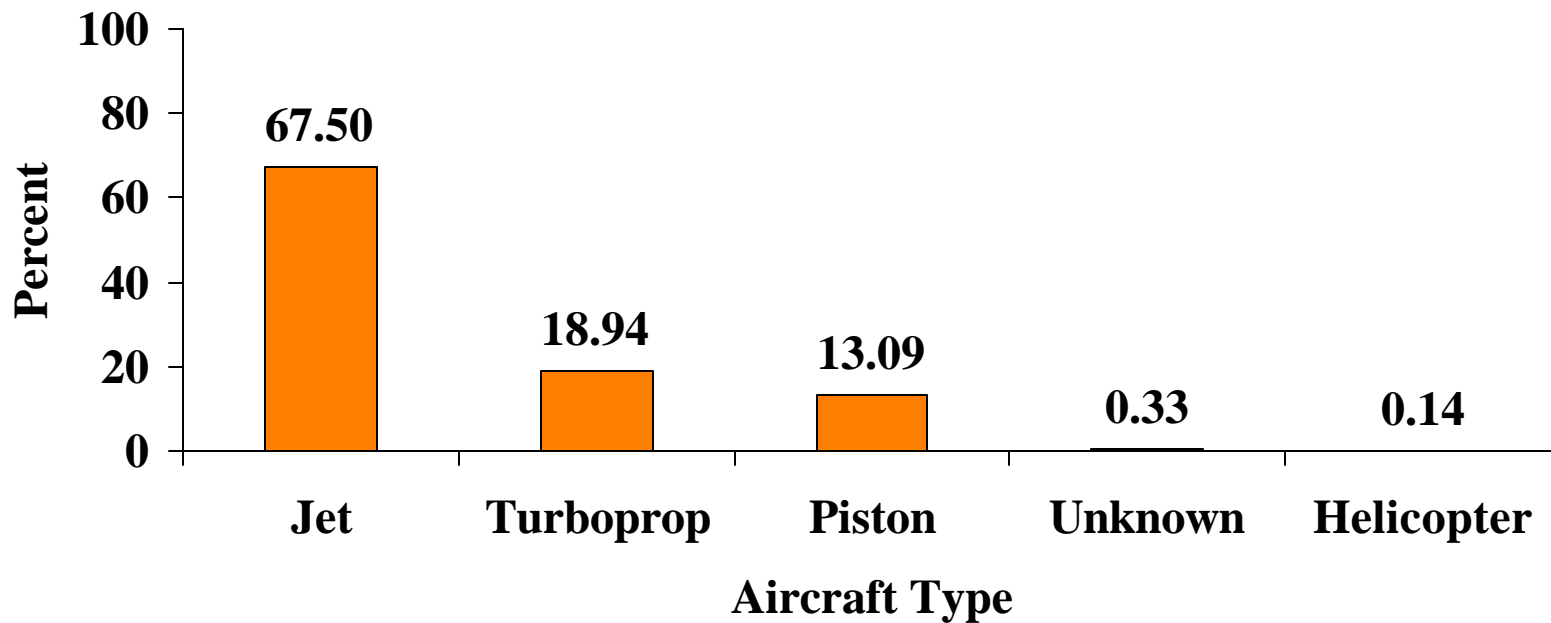
- **Metrics**

- Total Count
- Percent Total





Distribution of Aircraft by Type



Statistics for 10 hour sample
ZME without FP adherence



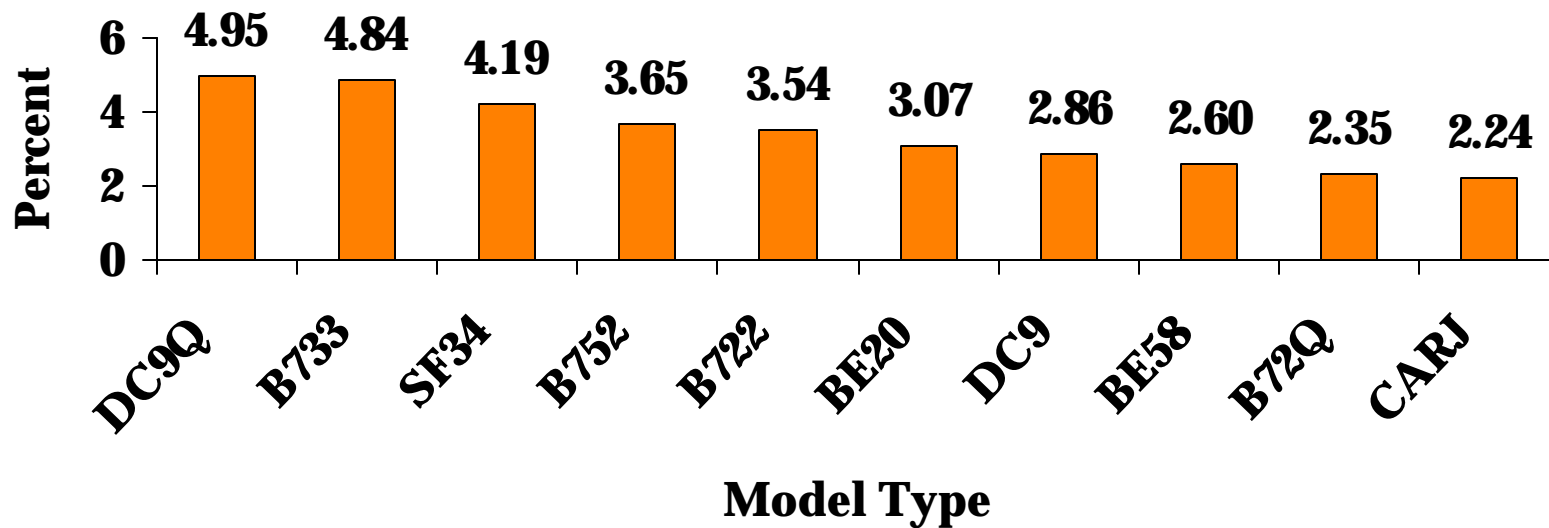
Aircraft Distributions

- **Aircraft Models Distribution**
 - Distribution of aircraft operating in center classified by model type
 - DC9, B733, etc.
- **Metrics**
 - Total Count
 - Percent Total





Distribution of Aircraft by Model - Top Ten -



Statistics for 10 hour sample
ZME without FP adherence



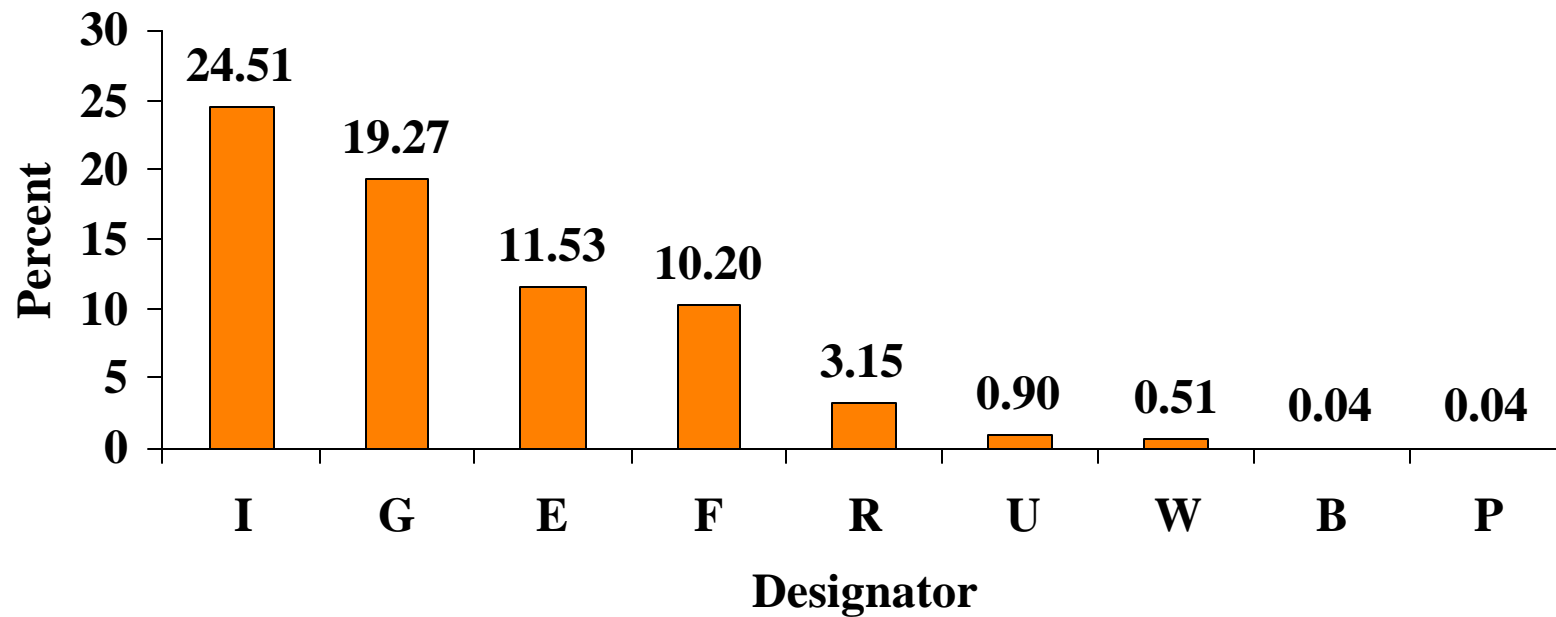
Aircraft Distributions

- **Navigation Equipage**
 - Distribution of navigational equipment aboard aircraft operating in center airspace
 - Classified as A, I, G, etc.
- **Metrics**
 - Total Count
 - Percent Total





Distribution of Navigation Equipage



Statistics for 10 hour sample
ZME without FP adherence





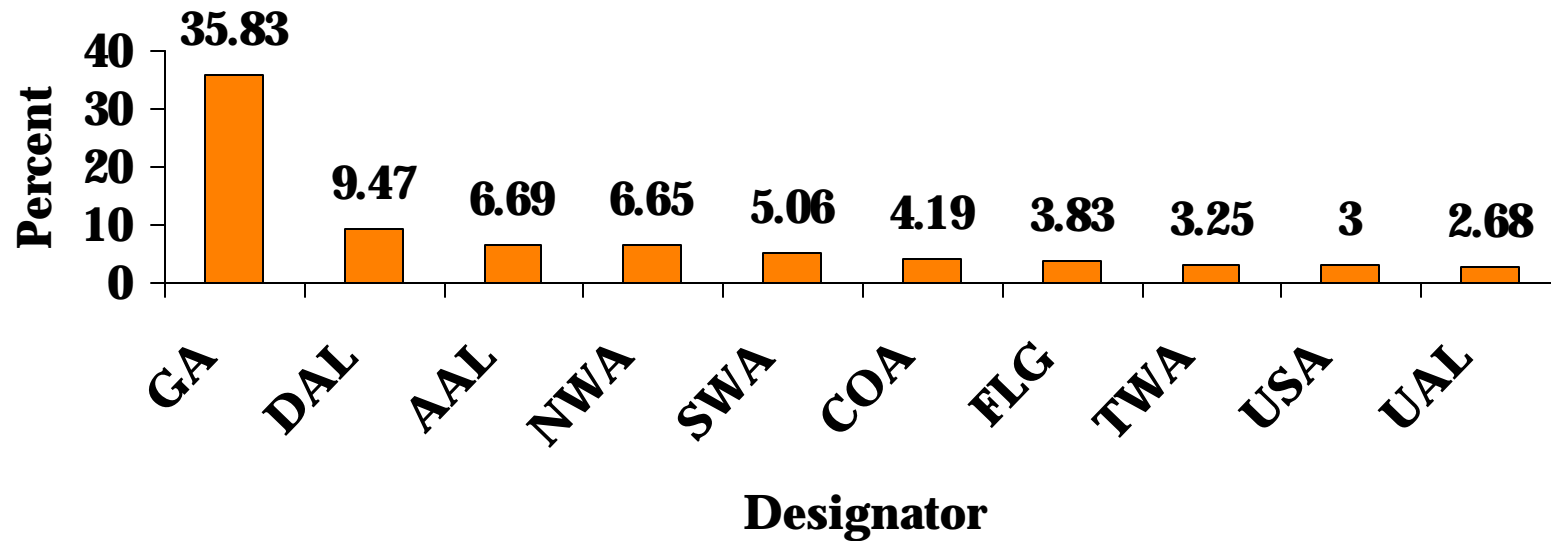
Aircraft Distributions

- **Carrier Distribution**
 - Distribution of carriers operating in center airspace
 - DAL for Delta Airlines, etc.
- **Metrics**
 - Total Count
 - Percentage Total





Air Carrier Distribution - Top Ten -



Statistics for 10 hour sample
ZME without FP adherence





Flight Plan Adherence

- **Lateral Flight Plan Adherence**
- **Vertical Flight Plan Adherence**





Flight Plan Adherence

- **Lateral Flight Plan Adherence**
 - Measure of aircraft lateral deviation from track report to converted route
- **Metrics**
 - Average Delta (nautical miles)
 - Std Deviation
 - Max and Minimum
- **Results**
 - TBD





Flight Plan Adherence

- **Vertical Flight Plan Adherence**
 - Vertical deviation from track reported altitude to assigned altitude
- **Metrics**
 - Average Delta (feet)
 - Std Deviation
 - Max and Minimum
- **Results**
 - TBD





Interfacility Traffic Flow

- **Definition**

- Rate of aircraft flying between facilities

ZID to ZME ZME to ZID

Other to ZME ZME to Other

- **Metrics**

- Count per Hour
- Average
- Std Deviation
- Max and Minimum

- **Results**

- TBD





Weather Variations

- **Variation**
- **Time Shifting Effect**





Weather Variations

- **Variation**
 - Change in wind speed and direction over time
 - Change in temperature over time
- **Metrics**
 - Average
 - Std Deviation
 - Median
 - Range
- **Results**
 - TBD





Weather Variations

- **Time Shifting Effect**
 - Comparison of trajectory accuracy with and without time shifting
- **Metrics**
 - Difference in accuracy as defined in *Trajectory Prediction Accuracy Report: URET/CTAS, (DOT/FAA/CT-TN99/10)*
- **Results**
 - TBD





Next Steps

- **Complete Metrics**
- **Apply smoothing technique for Phase of Flight**
- **Assist with WARP1 conversion**





Some Accuracy Scenario Risk Areas

- CMS Format Conversion
 - Cause: CMS IRD is moving target with continuous stream of RPRs and lack of a definition of the file required for accuracy
 - Mitigation:
 - » develop close relationship with LMATM by working on new SIG 264 to define the CMS-formatted scenario
 - » provide preliminary CMS-formatted scenario messages to LMATM for verification with their tools
- RUC 236 WARP1 Conversion
 - Cause: dependent on shareware, etc.
 - Mitigation:
 - » work with AST for early date test run (~Feb. or March 2000)
 - » LMATM help?
 - » MITRE help?





Some Accuracy Scenario

Risk Areas Cont'd

- Meeting Encounter Constraints With Flight Adherence
 - Cause: dealing with real traffic and limited sample data
 - Mitigation:
 - » time shifting and backup method of cloning
 - » we can set lateral deviation thresholds accordingly
(vertical is already defined in SSD)
- Trajectory Accuracy Degradation from Time Shifting
 - Cause: weather data may not be time synchronized due to time shifting of flights
 - Mitigation:
 - » specification refresh will level the playing field
 - » perform brief trajectory accuracy comparison to original field data

